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PATENT SPECIFICATION

Inventor: TAMEICHI IMAGAWA

696,146

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COMPLETE SPECIFICATION

Method of and Apparatus for Manufacturing Metallic Articles by Connecting Metal Pieces Together by Cast Alloy

We, THE BRIDGESTONE BICYCLE COMPANY LIMITED, No. 1, 1-chome, Kyobashi, Chuo-ku, City of Tokyo, Japan, a Japanese Corporation, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particulaly described in and by the following statement:—

This invention relates to a method of manufacturing bicycle frames by means of a die casting machine using aluminium alloy and the apparatus therefor, and more particularly to a method of manufacturing a part or the whole of a bicycle frame.

The principal object of this invention is to manufacture bicycle frames of higher quality quickly and in greater quantity at lower cost.

In the manufacture of the most common type of bicycles it has heretofore been usually customary to use pieces of steel tubes which are assembled to a desired shape and fixed to each other by electric welding, brazing or oxy-hydrogen gas welding process.

It has however, been proposed to join pieces of steel tubes positioned in a two part mould, by means of a molten alloy for manufacturing a bicycle frame.

According to the present invention, a bicycle frame is made by assembling metal tubes which were previously cut or finished to a desired shape and dimension in a metal mould leaving required spaces around the joints, and by forcing, with high pressure, a molten aluminium alloy containing 6 to 15% of silicon, 10 to 28% of zinc, 0.1 to 1.0% each of chrome, manganese and magnesium respectively and the remainder aluminium and some impurities into the spaces left in the metal mould, thereby enclosing and embedding the required parts of the metal tubes in the cast alloy so as to firmly connect together the tube ends by the shrinkage of cast alloy and also by the amalgamation on the contact surface.

In order that the invention may be fully understood we shall describe in detail a method of the manufacture of a bicycle frame in connection with the accompanying drawings, in which:—

Fig. 1 is a front view of metal tube pieces assembled to form a head part of the bicycle frame;

Fig. 2 is a side view of Fig. 1;

Fig. 3 is a plan view of a metallic mould for manufacturing a head part of the bicycle frame as an embodiment of this invention;

Fig. 4 is a sectional side elevation taken on the line A—A of Fig. 3;

Fig. 5 is a similar view on the line B—B.

Fig. 6 is a front view partly in section of a high pressure casting machine adapted for use with this invention;

Fig. 7 is a plan view of complete metallic mould for casting three joints, i.e., the head portion, the seat portion and the bracket portion at the same time by this invention;

Fig. 7*a* is a plan view of the chain stay; and

Referring now to Figs. 1 to 6, a method of manufacturing the head portion of a bicycle frame according to this invention is illustrated, wherein 1, 2 and 3 represent pieces of metal tubes cut to a required length the pieces 2 and 3 being fitted at one end to the piece 1. 4 and 5 represent an upper and the lower half portion of an iron mould respectively having the recess 6 formed therein for receiving the steel tube pieces 1, 2 and 3, and the space for molten metal to be filled around these pieces and a bottom pouring opening 7 as well as flow passages 8 communicating with the recess space 6 are formed exculsively in the lower mould

5 and the lower surface of the upper mould 4 is preferably made flat without communicating passages. The steel tube pieces 1, 2, and 3 as shown in Fig. 1 are put in the mould 5 as shown in Fig. 3 with a core rod 9 passed through the tube 1 and fitted into the nuts 10 at both ends and collars 11 engaging the tubes 2 and 3. The core rod 9 supports the tube 1 exactly on the central axis and also by the aid of the nut 10 prevents the molten metal flowing into the tube 1. The collar 11 is split into two pieces and supports the tubes 2 and 3 and prevents the flowing out of molten metal. Suitable means, not shown, are provided for closing the ends of pipes 2 and 3. 12 represents an air exit recess which is preferably made as a very narrow gap in order to quickly solidify the molten metal before it flows out of the mould. Thus the upper mould 4 is put on the lower mould 5 at the correct position guided by means of pins 13, then the assembling of iron moulds is completed ready for casting.

Referring now to Fig. 6, 14 represents a preferred example of the casting machine to be used in the present invention, wherein 15 shows a hydraulic cylinder fixed to the upper bracket 16 which is fixed to four supporting stancheons 17 projected vertically on the base 18. The piston 19 slidably fitted in the hydraulic cylinder carries at the lower end of the piston rod a movable press board 20 having an attached frame 21, to which the upper mould 4 is secured by suitable means such as bolts and nuts (not shown). 22 represents a pneumatic cylinder fixed to the base having a piston slidably fitted therein. At the upper end of the piston rod 24, there is provided a second piston 25 which fits into a cylindrical hole 26 formed in the bed plate 18 serving as the molten metal receiver. 27 represents a valve box enclosing all valve devices for controlling the supply and exhaust of pressure fluids to and from the cylinders 15 and 22 respectively.

In operating the casting machine 14, the lower mould 5 as shown in Fig. 3 fitted with steel tube pieces is placed on the base 18 of the casting machine and the projecting parts of the steel tubes 2 and 3 are clamped by suitable chucks 28 and 28' respectively, which are secured to the base for preventing shifting of the steel tubes. Then the molten metal melted in a suitable furnace and reserved in a heat insulating pot or heating furnace is poured into the cylinder 26 and the pressure liquid is supplied to the upper chamber of the hydraulic cylinder 15 by operating the valve device to lower the piston 19 and the press board 20 together with the upper mould 4 until the latter tightly contacts with the lower mould 5 and is held by sufficient pressure therein. Then the air control valve is operated to supply compressed air into the lower side of the cylinder 22, thereby forcing up the piston 23 so that the molten metal filling the upper cylinder 26 is forced out into the mould with high pressure and supplied to the space 6 (Fig. 3) around the steel tubes 1, 2 and 3 expelling the air in the space through the gap or air exit 12. After a certain time when the molten metal filled in the space 6 has solidified the upper mould 4 is lifted by operating the hydraulic piston 19 upwardly and the cast article is taken out of the lower mould and the metal solidified in the flow passages is cut off by suitable means. Thus the head part of bicycle frame consisting of steel tube pieces 1, 2 and 3 joined together by means of cast alloy is obtained very easily. I have found that the cast alloy surrounding the ends of steel tube pieces to be joined together firmly clamps the ends by the shrinking force when the casting solidifies and it tightly amalgamates with the tube pieces so that the latter can be most positively joined together in correct relation without deformation.

Fig. 7 illustrates a special metallic mould as a modified embodiment of this invention for making three joints of the main bicycle frame in one operation, wherein 29 represents a lower iron mould having three casting portions 30, 31 and 32. The iron mould 30 for making the lead part 33 of a bicycle frame is constructed just like the iron mould as illustrated by Figs. 3 to 5. The iron mould 31 for the seat part joint and the iron mould 32 for the bracket part joint 35 can be constructed similarly to the iron mould 30 for the head part 33. 36, 37 and 38 represent pieces of steel tube or light alloy tube cut to required lengths. 39, 40 and 41 represent cores or nuts similar to 9 and 10 in Fig. 3. 42 and 43 are split collars like 11 in Fig. 3 for clamping the tube pieces and for stopping the flowing out of molten metal. A single supply port 44 for molten metal is provided for the lower mould at about the central position of the triangle formed by the tubes 36, 37 and 38 flow passages 45 being provided and air vents similar to 12 in Figs. 3 and 5. 48 shows guide pins and 49 represents a chain stay of bicycle. The upper iron mould (not shown) is made in a similar manner to that as already explained with reference to Figs. 3 to 5.

The iron mould shown in Fig. 7 may be secured to the casting machine as shown in Fig. 6 and can be operated in a similar manner to that already explained for making the head portion of the bicycle

frame, thus the three joint portions, that is, a main bicycle frame can be cast together in one operation. Accordingly more accurate bicycle frame can be manufactured very quickly at a reduced cost.

A copper alloy or other alloy may be used for jointing metal pieces by the method of this invention, yet the inventor has found that special aluminium alloy is most suitable for the purpose. Such a special aluminium alloy contains 6 to 15% of silicon, 10 to 28% of zinc, 0.1 to 1.0% each of chromium, manganese and magnesium and the remaining of aluminium and some impurities. Addition of zinc to aluminium increases the strength, yet the maximum tensile strength is not higher than 24 Kg per square millimeter with a casting up to 20% of zinc and the addition of silicon up to 13% to aluminium increases its strength, but the maximum tensile strength is not more than 20 Kg per square millimeter. On the contrary, if zinc and silicon are added to aluminium the strength is greatly increased by the combined effect and the maximum tensile strength up to 25 to 35 Kg/mm^2 can be developed by a suitable selection of percentages of these elements and the casting facility is promoted. Addition of a small amount of chromium and magnesium to the Al—Si—Zn alloy increases the strength of the alloy from about 10 to 20% and chromium eliminates some adverse effect of zinc. Manganese is effective for avoiding the adverse effect of iron contained in the raw material used.

As an example, the aluminium alloy containing 19% Zn, 11% Si, 0.1% Mn, 0.1% Mg, and 0.1% Cr shows the tensile strength of 25.2 Kg/mm^2, the elongation of 0.7% and Brinel hardness number of 123 when cast in a metal mould. As another example, the aluminium alloy containing 19% Zn, 11% Si, and 0.5% each of Mn, Mg and Cr cast in an iron mould shows the tensile strength of 33.8 Kg/mm^2, elongation of 0.6% and Brinel hardness of 140.

The above alloy in the molten state is forced in the metal mould by the casting machine as shown in Fig. 6 with high pressure and the higher the pressure the better result can be obtained. It is usually sufficient with the pressure of 10 to 30 Kg/cm^2. Knurling 54 as shown in Fig. 1 or annular grooves may be provided on the outer surface of the steel tubes 1, 2 and 3 in order to increase the contact surface. When copper alloy is used the contact surface of the steel tube is ground and heated and coated with flux to form amalgamated structure between the cast alloy, thereby providing more strong joints.

The molten alloy cast around the steel or alloy tubes acts as a joint for the tube pieces to be connected together and firmly clamps them by the shrinkage of the molten metal when it solidifies. The above mentioned aluminium alloy has relatively low melting point so that the steel or alloy tubes are not so over-heated as to cause deformation and there is no need of special finishing process such as correcting finishing. The metal mould may be made to any desired shape and also a special design can be engraved on the inner surface for providing a pipe joint having complicated shape and design thereon.

What we claim is:—

1. A method for the manufacture of a bicycle frame by casting molten metal around the end portions of metal tubes wherein the end portions of metal tubes, cut to a required length, are placed at predetermined relative positions in a metallic mould which has a continuous space left therein around said end portions of the metal tubes to be joined together, pouring molten aluminium alloy containing 6 to 15% of silicon, 10 to 28% of zinc, 0.1 to 1.0% each of chromium, manganese and magnesium respectively and the remainder aluminium and some impurities into said space in the mould under high pressure, removing the solidified mass from the metallic mould and fettling the cast metal, thereby providing a bicycle frame which consists of metal tubes joined together by a cast metal mass enclosing and firmly clamping the end portions of said metal tubes as a unit.

2. An apparatus for manufacturing a bicycle frame, according to the method of claim 1, comprising in combination a metallic mould consisting of upper and lower members having recesses between them to receive the ends of the metal tubes to be joined, and providing a space thereabout serving as the casting space, including hydraulically operated cylinder for lifting and lowering the upper member of said metallic mould and a pneumatically operated cylinder having an upper auxiliary piston moving in a cylindrical molten metal receiver communicating with a passage formed in said mould to force molten alloy in said receiver into the mould under high pressure.

3. Apparatus for manufacturing a bicycle frame according to claim 2, including a gas exit gap provided between said upper and lower metallic moulds serving also as overflow passage for the superfluous molten metal.

4. A bicycle frame made by the method according to claim 1, characterised in that pieces of metal tubes are connected together by a single cast mass of metallic alloy formed by pouring the molten alloy

into spaces between the end portions of said metal tubes and the inner surface of the metallic mould at high pressure such as 10 to 30 Kg per square centimetre.

5. A metallic mould for manufacturing a bicycle frame according to the method of claim 1, constructed substantially as described with reference to Figs. 3, 4, 5 and 7 of the accompanying drawings.

6. An apparatus for manufacturing a bicycle frame according to the method of claim 1, constructed, arranged and adapted to operate substantially as described with reference to Figs. 6 and 7 of the accompanying drawings.

7. An improved method of and means for manufacturing metallic articles substantially as herein described with reference to the accompanying drawings.

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Chartered Patent Agents.

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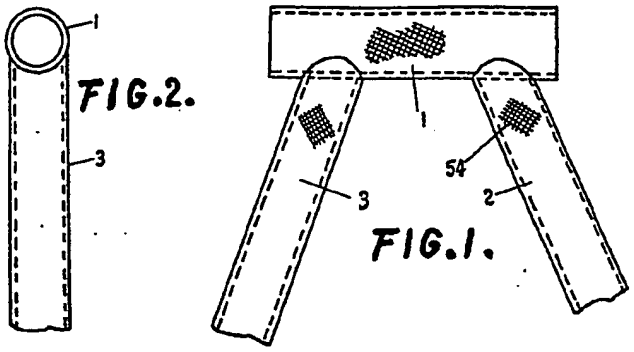


FIG.2.

FIG.1.

FIG.3.

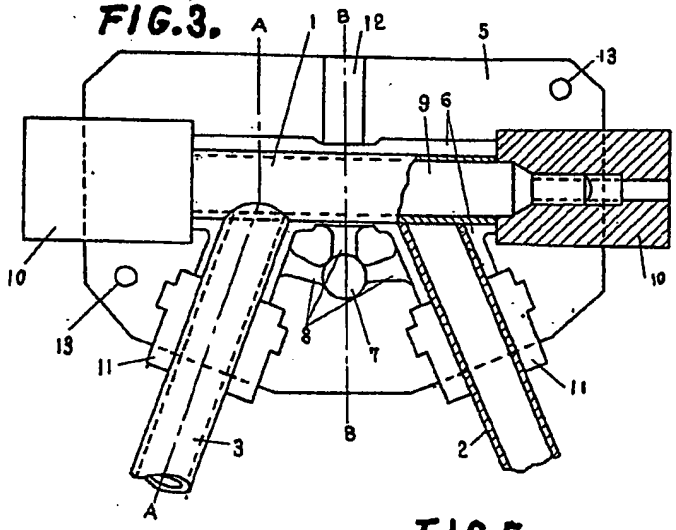


FIG.4.

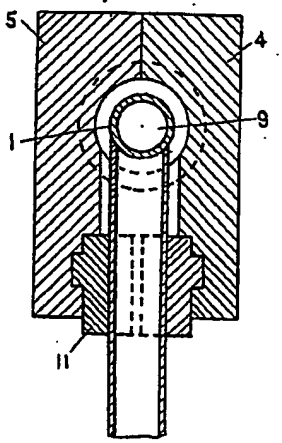
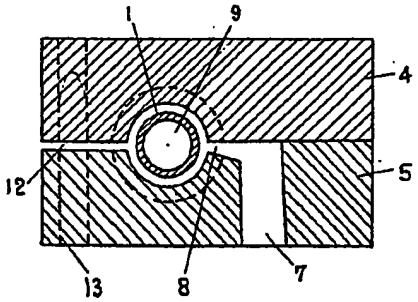


FIG.5.

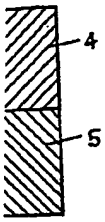


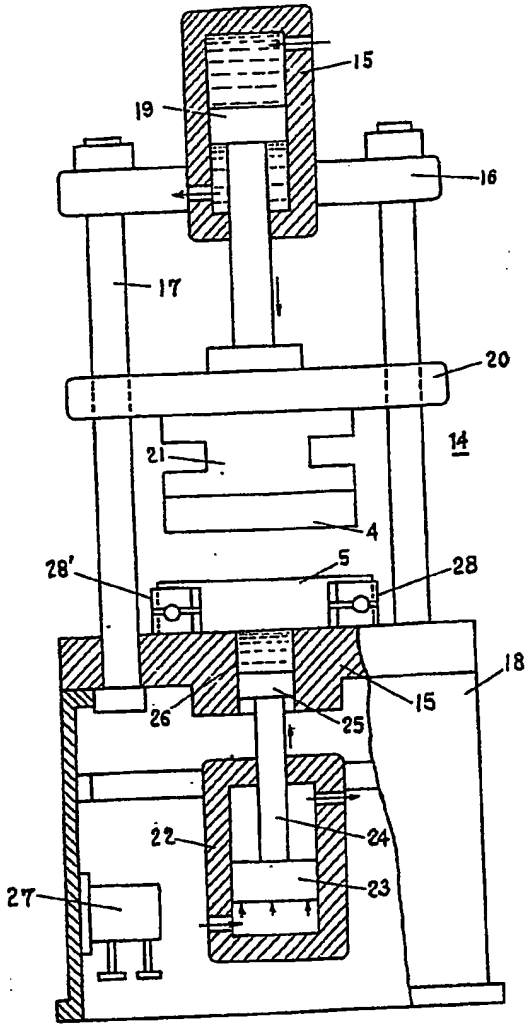
696,146 COMPLETE SPECIFICATION

3 SHEETS *This drawing is a reproduction of the Original on a reduced scale.*

SHEETS 1 & 2

FIG.6.





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SHEETS 1 & 2

FIG.2.

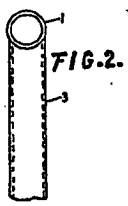


FIG.1.

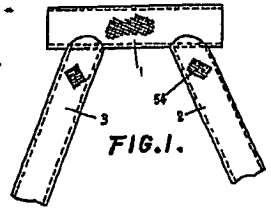


FIG.3.

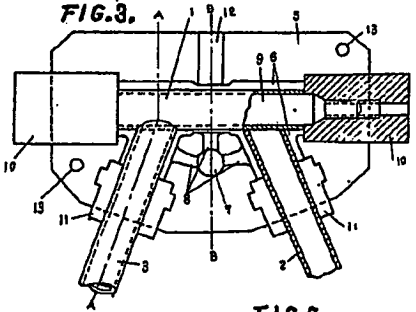


FIG.4.

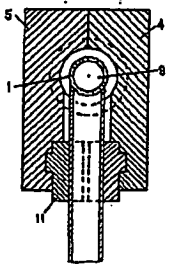


FIG.5.

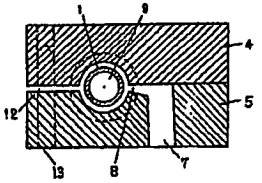
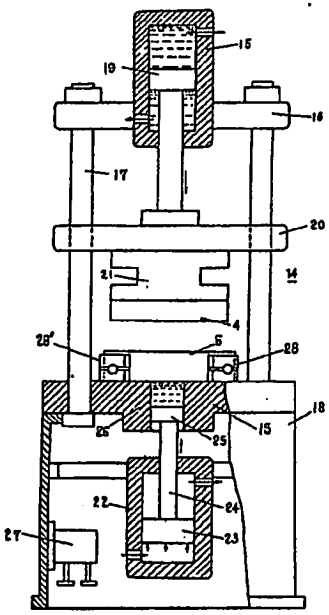


FIG.6.



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SHEET 3

FIG.7.

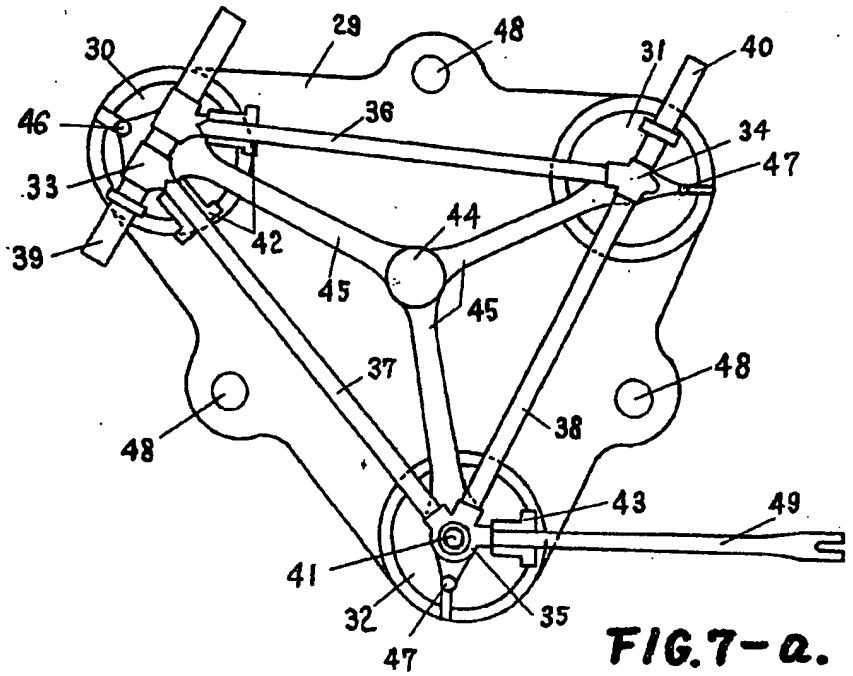

FIG.7-a.